EXHIBIT 4

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
TYLER DIVISION

LONE STAR TECHNOLOGICAL INNOVATIONS, LLC, Plaintiff, v. ACER INC., ET AL, Defendants.	Civil Action No. 6:15-CV-973 (JRG-JDL) LEAD CASE

DECLARATION OF IAIN E. RICHARDSON, PH.D.

Pursuant to 28 U.S.C. § 1746, I, Iain E. Richardson, declare as follows:

1. I offer this declaration on behalf of Defendants Acer Inc., Acer America Corporation and Sharp Electronics Corporation (collectively, "Defendants"). I have been asked to provide an opinion concerning certain language that appears in U.S. Patent Nos. 6,122,012 ("'012 Patent") and 6,724,435 ("'435 Patent"). If called upon, I would be willing and able to testify as set forth in this declaration.

I. BACKGROUND AND QUALIFICATIONS

2. I am qualified by education and experience to testify as an expert in the field of digital video processing. Attached as Exhibit A is a copy of my curriculum vitae detailing my experience and education. Additionally, I provide the following overview of my background as it pertains to my qualifications for providing expert testimony in this matter.

3. I founded three companies specializing in digital video processing technology: 4i2i Communications Ltd (Director, 1995-2000), Vcodex Ltd (Director, 2007-present) and OneCodec Ltd (Director, 2009-2015; merged with Vcodex Ltd in 2015).

4. I am Honorary Professor of Video Coding at the Robert Gordon University, Aberdeen, Scotland. I joined the University in 1993 as a Lecturer. I founded the image and video coding and communications research laboratory in 2000 and led a team of researchers from 2000-2009.

5. I received the MEng in Electronic Engineering from Heriot Watt University in 1990 and gained my PhD in Video Coding from the Robert Gordon University in 1999.

6. I am an experienced designer of digital video processing systems in both software and hardware. I have designed and implemented video compression codecs and systems for processing digital video, including color control and conversion.

7. I am the author of four books and over 70 journal and conference papers on video coding and digital video processing.

8. I am frequently invited to speak and consult on video coding and digital video processing technology by academic institutions and companies worldwide. For example, I have given a number of invited lectures to patent examiners at the USPTO, including most recently a lecture on digital video quality perception and measurement (June 2016).

9. I am a contributing member of ISO/IEC JTC 1/SC 29/WG 11, a working group of ISO/IEC responsible for developing video compression standards and more commonly known as the Moving Picture Experts Group, MPEG.

10. I studied and wrote about the particular technology at issue in this case, namely digital video processing and color control, in my books: “Video Codec Design” (2012), “H.264 and MPEG-4 Video Compression” (2003), and “The H.264 Advanced Video Compression Standard” (2010). For example, my book “Video Codec Design” includes a chapter on digital video capture, display and color conversion (Chapter 2).

II. SUMMARY OF OPINIONS

11. As set forth below, it is my opinion that the disputed terms have the following meanings.

Claim Term	Construction
"a set of individual color look-up-tables"	This term is indefinite under 35 U.S.C. § 112(2) to the extent that "individual color" is indefinite under 35 U.S.C. § 112(2). "a set of tables, each mapping an input individual color to an output individual color"
"individual color control functions"	This term is indefinite under 35 U.S.C. § 112(2) to the extent that "individual color" is indefinite under 35 U.S.C. § 112(2). "functions that each operate on linear combinations of values of the input image chromatic components for an individual color"
"color control parameters"	"the change of the output image chromatic component from the input image chromatic component for a specific color"
"whereby all other colors of the digital video input image remain unchanged"	"whereby all other pixels of the digital video input image without the same color component values remain unchanged"
"individual color"	This term is indefinite under 35 U.S.C. § 112(2). Should the Court find that this term is definite, the term should be construed as follows: "a specific linear combination of color components such as red, green, blue, yellow, cyan and magenta"
"characterizing"	This term is indefinite under 35 U.S.C. § 112(2).
"arbitrary interval of integers"	This term is indefinite under 35 U.S.C. § 112(2).
"completely independent and separate"	This term is indefinite under 35 U.S.C. § 112(2).

III. THE ASSERTED PATENTS

12. The ’012 Patent and the ’435 Patent both name the same sole inventor, Yosef Segman, and both relate generally to controlling colors in digital video images. Both patents purport to describe and claim novel methods of controlling “individual colors,” though as discussed below, it is unclear from the patents what an “individual color” is.

13. In the ’012 Patent, a color in a digital video image is selected to be controlled. A set of “look-up-tables” or “LUTs” are defined for the individual color. In computer processing, a LUT is an array into which values are input and indexed for retrieval. The values in a LUT are accessible from memory and need not be calculated in real time during calculation.

14. Values for the LUT in the ’012 Patent are calculated using “color control functions,” and these values are assigned to “color control parameters.” The values are inserted into the LUTs, and new values are determined to define a new color. The values are used to determine the values of pixels in an output image such that only the chosen individual color is changed.

15. The ’435 Patent is similar to the ’012 Patent in that it concerns the control of an “individual color.” Rather than using LUTs, however, the alleged invention in the ’435 Patent specifically changes the hue or saturation – two aspects of a particular color – in order to change an individual color. The changes in hue or saturation are based on “delta values,” which simply represent the extent of change in either hue or saturation. The hue and saturation are changed by “independent color hue control functions” and “independent color saturation control functions” that use the delta values to set new values for hue and saturation.

IV. LEGAL PRINCIPLES

16. I understand that claim construction is a matter of law and that the Court ultimately may construe the meanings of certain terms in dispute.

17. I understand that a claim must be read in the context of the entire patent. In particular, the words of the claim must be read in view of the entire specification. The specification is the best guide for construing the claims. In addition to consulting the specification, one should also consider the prosecution history. Extrinsic evidence can also be consulted, but should not be relied upon to contradict the intrinsic record.

18. I understand that the interpretation of patent claim language is to be undertaken at the time of the filing of the patent application or the earliest priority date claimed by the patent applicant(s). The patent application that gave rise to the ’012 Patent was filed on March 3, 1999. The ’435 Patent was filed on August 6, 2001. Accordingly, I have used these dates as my point of reference for interpreting the meaning of the terms identified herein. For the terms that appear in both patents, unless stated otherwise, the specific filing date does not affect how the claim would have been interpreted by one of ordinary skill in the art. Based on my professional and educational background, including review of literature from the time frames in which the ‘012 Patent and ’435 Patent were filed and my own experience during said time frames, I can interpret how a person of ordinary skill in the art would have construed the claims of the ‘012 Patent and the ’435 Patent in the 1999-2001 time frame.

19. I have been informed and understand that 35 U.S.C. § 112 ¶ 2 recites: "The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention." I understand that a patent claim that does not meet this standard may be invalid as indefinite. I also understand that this standard is met when a person experienced in the field of the invention would understand the scope of the subject matter that is patented when reading the claim in conjunction with the rest of the specification. Conversely, a claim is indefinite if it does not reasonably inform a person of

ordinary skill in the art of the scope of the claimed invention and thus whether a particular product or method infringes or not.

V. CLAIM TERMS

A. "a set of individual color look-up-tables"

20. The term "a set of individual color look-up-tables" appears in claims 1, 3, 11 and 13 of the '012 Patent. As discussed below, the phrase "individual color" is indefinite and thus the term "a set of individual color look-up-tables" is also indefinite. To the extent the term "a set of individual color look-up-tables" is amenable to construction, in my opinion the term should be construed as "a set of tables, each mapping an input individual color to an output individual color."

21. A person of ordinary skill in the art would have understood that each look-up-table, or LUT, operates on a specific color. A LUT would be set to receive a particular input color and to output a particular output color. In this sense, the input color is "mapped" to the output color because each output color produced by the LUT is in response to a particular input color..

22. This is explained in the book *Electric Imaging Technology*, edited by Edward R. Dougherty and published in 1999. As explained in that book, "*Color mapping* maps data to colors. Most often the mapping is applied to scalar data, but schemes exist to map multiple variables to different components of color." DEFS_PA_00002379 (emphasis in original). The book goes on to explain that "For scalar color mapping, the mapping is implemented by using the scalar values as indices to a list of colors. This is called a *color lookup table* or LUT." *Id.* (emphasis in original).

23. Accordingly, a person of ordinary skill in the art would understand "a set of individual color look-up-tables" to mean "a set of tables, each mapping an input individual color to an output individual color."

B. "individual color control functions"

24. The term "individual color control functions" appears in claim 1 of the '012 Patent. As discussed below, the phrase "individual color" is indefinite and thus the term "individual color control functions" is also indefinite. To the extent the term "individual color control functions" is amenable to construction, in my opinion the term should be construed as "functions that each operate on linear combinations of values of the input image chromatic components for an individual color."

25. The specification explains that "[s]ets of individual color control functions are . . . used for digitized selective control of individual colors, by operating on linear combinations of the values of the input image chromatic components." '012 Patent at 6:28-32. The phrase "digitized selective control of individual colors" refers to changing individual colors by altering the discrete digital values that define those colors. The '012 Patent explains that "an individual color represents a linear combination of the base colors, whereby the base colors feature red, green, blue, yellow, cyan, and magenta." *Id.* at 1:31-34. Accordingly, the color control functions operate on the linear combinations of the base color values that make up the individual color. These base color values are the "values of the input image chromatic components" referenced in the specification's explanation of how the color control functions operate.

26. In sum, to the extent the term "individual color control functions" is amenable to construction, in my opinion the term should be construed as "functions that each operate on linear combinations of values of the input image chromatic components for an individual color."

C. "color control parameters"

27. The term "color control parameters" appears in claim 1 of the '012 Patent. In my opinion, the term "color control parameters" should be construed as "the change of the output image chromatic component from the input image chromatic component for a specific color."

28. As explained above, the color control functions operate on base color values, or chromatic components, that make up individual colors. Claim 1 explains that values are assigned to "color control parameters in said set of individual color control functions." The values are then inserted into LUTs and new values are determined to define the output color. Thus, the color control parameters are simply the changes in the chromatic components, such as Cr and Cb, that make up individual colors.

29. Accordingly, the term "color control parameters" should be construed as "the change of the output image chromatic component from the input image chromatic component for a specific color."

D. "whereby all other colors of the digital video input image remain unchanged"

30. The term "whereby all other colors of the digital video input image remain unchanged" appears in claim 1 of the '012 Patent. In my opinion, the term "whereby all other colors of the digital video input image remain unchanged" should be construed as "whereby all other pixels of the digital video input image without the same color component values remain unchanged."

31. As explained above, individual colors are defined by linear combinations of color component values. Claim 1 recites a method of controlling an individual color by manipulating these color component values. Claim 1 is clear that this color adjustment is applied to individual pixels containing specific color component values, *i.e.* individual pixels containing the specific

individual color to be adjusted. In particular, after the color control functions and color control parameters are used to determine new values in LUTs, the claim recites "determining values *of pixels* in said target output image from said new values in said set of individual color look-up-tables" (emphasis added). These values are determined by establishing a particular linear combination of color components. Accordingly, only pixels with that specific combination would be affected, and "all other pixels of the digital video input image without the same color component values remain unchanged."

32. This is confirmed in the specification, which explains that "[i]n the general case, output image *pixel values* featuring the new chromatic components, Cr'(i,j) and Cb'(i,j), are obtained by having, the individual color LUTs operate on a linear combination of the input image chromatic components, Cr(i,j) and Cb(i,j) . . . ." '012 Patent at 15:51-55 (emphasis added). In other words, the output image pixel values are determined by specific color component combinations, and only those pixels with the specific combination to be operated upon will be affected.

33. Accordingly, the term "whereby all other colors of the digital video input image remain unchanged" should be construed as "whereby all other pixels of the digital video input image without the same color component values remain unchanged."

E. "individual color"

34. The term "individual color" appears in all asserted claims of the '012 Patent and in claims 1, 2, 10, 11, 13-18, 26, 27, and 29-32 of the '435 Patent. Both patents purport to define "individual color" as "a linear combination of the base colors, whereby the base colors feature red, green, blue, yellow, cyan, and magenta." *See, e.g.*, '012 Patent at 1:32-34; '435 Patent at 1:19-22 (similar definition). Based on this definition, the alleged invention described in each patent must change the linear combination itself, *i.e.* the complete "individual color."

35. This is inconsistent with the descriptions of the alleged inventions described in the specifications of each patent. In both patents, individual color components – *i.e.*, the base colors themselves – are controlled, *not* linear combinations of components.

36. For example, the method described in the ’012 Patent manipulates the individual chromatic components Cr and Cb in order to control an “individual color.” *See, e.g.*, ’012 Patent at 4:18-63. But manipulating these chromatic components will affect *all* linear combinations that contain either component, not a single “individual color” as defined in the specification.

37. Furthermore, the control of an “individual color” as described above suggests that an “individual color” is not a “linear combination of the base colors” such as red, green, blue, yellow, cyan, and magenta, but is instead a combination of chromatic components Cr and Cb. For example, the ’012 Patent at 4:66-5:1 defines “individual color” as a “color [that] is composed of a linear combination of the input image chromatic components Cr and Cb” contrary to the definition provided at 1:32-34 of the ’012 Patent. Chromatic components Cr and Cb are not represented by a linear combination of the base colors, such as red, green, and blue (or their complementary colors, yellow, cyan, and magenta). As I explain on pages 12-15 of my 2002 book, “Video Codec Design”, each chromatic component Cr and Cb is a difference between a base color (red or blue) and a luminance or weighted average of **three** base colors (red, green and blue). Operating on an “individual color” that is a “linear combination of.. Cr and Cb” would require a conversion that the ’012 Patent specifically states should not be done. “Application of this method to video images precludes the need to convert video components (*e.g.*, YCrCb) into RGB (red, green, blue) components.). ’012 Patent at 2:6-8

38. Similarly, in the ’435 Patent, color is controlled by manipulating hue or saturation. *See, e.g.*, ’435 Patent at 7:15-30. But manipulating hue or saturation necessarily affects a range of colors, not an individual linear combination of colors.

39. Furthermore, the ‘435 Patent purports to give examples of identifying input image pixels having an “individual color whose hue or saturation was selected to be independently changed” (‘435 patent 10:25-11:13). However, the examples given each refer to identifying input image pixels having a base color as the “individual color”, where the base color is red, green, blue, yellow, cyan or magenta. Clearly a specific base color is different from a linear combination of (plural) base colors.

40. Accordingly, neither the ’012 Patent nor the ’435 Patent uses the term “individual color” in a coherent manner. Both patents purport to define “individual color” as a linear combination of color components, but then describe the invention in a manner that makes it impossible to control an “individual color” as claimed.

41. Accordingly, in my opinion the term “individual color” is indefinite.

F. “characterizing”

42. The term “characterizing” appears in claims 1 and 17 of the ’012 Patent and claim 1 of the ’435 Patent.

43. Claims 1 and 17 of the ’012 Patent each recite “receiving the digital video input image, featuring pixels,” followed by “characterizing the digital video input image and its target output image.” Similarly, claim 1 of the ’435 Patent recites “receiving and characterizing the real time digital video input image featuring input image pixels.”

44. The ’012 Patent does not adequately explain what is meant by “characterizing,” and the term has no plain and ordinary meaning to one of ordinary skill in the art. The ’012 Patent specification purports to explain the “characterizing” step from the claims at column 4,

lines 17-63. However, this description fails to convey to one of ordinary skill in the art what is meant by "characterizing." In particular, in the first substep of the "characterizing" step, the values "Cr and Cb are defined as two chromatic components of a digital video input image at time t, Cr or Cb can be plotted in an input image grid (not shown) having an input image grid coordinate system featuring rows (lines) and columns (pixels)." *Id.* at 4:19-23. But this description does not explain *how* the chromatic components are defined, or what it means to define them. Without this first step, the remaining explanation of "characterizing" does not reasonably inform a person of ordinary skill in the art of the meaning of "characterizing." Furthermore, in the second substep of the "characterizing" step, it is stated that "Cr(i,j) and Cb(i,j) are defined as digitized pixel values of the input image chromatic components Cr and Cb, respectively, whose position coordinates are (i,j)". However, it is unclear how, if at all, Cr(i,j) and Cb(i,j) in this second substep differ from Cr and Cb specified in the first substep, since the two "defined… chromatic components" recited in the first substep are described as capable of being "plotted in an input image grid" and having pixel position coordinates "represented as (i,j)". One of ordinary skill in the art is left unclear as to what is meant by the two substeps (a) and (b) of "characterizing" and how to put these steps into practice.

45. The '435 Patent likewise provides no guidance as to what is meant by "characterizing" as a step performed in a method. The specification states only:

> In Step (a) of the method of the present invention, there is receiving and characterizing a real time digital video input image. Preferably, there is receiving a real time digital video input image, I, featuring colors or color components characterized by linear combinations of the basic colors red, green, and blue, in RGB color

> space, whereby the real time digital video input image, I, features basic colors red, green, and blue, and, complementary colors yellow, cyan, and magenta, in the RGB color space featuring a color based three-dimensional coordinate system.

’435 Patent at 6:40-50. But “characterizing” in this sense only describes the colors within the video input image. It says nothing about what is involved in characterizing the input image itself. Accordingly, it is entirely unclear from the claim language and the specification what is meant by “characterizing” how the step of “characterizing the real time digital video input image” is accomplished.

46. Thus, the term “characterizing” is indefinite in both the ’012 Patent and the ’435 Patent.

G. “arbitrary interval of integers”

47. The term “arbitrary interval of integers” appears in claims 5 and 21 of the ’435 Patent. Both claims recite the limitation, “whereby [] numerical range of said independent color hue control delta value and numerical range of said independent color saturation control delta value corresponds to an arbitrary interval of integers.” The delta values in the respective independent claims from which claims 5 and 21 depend simply represent the “extent of change” in hue or saturation of an individual color. Accordingly, claims 5 and 21 purport to set specific limits on the range within which these delta values can be set.

48. However, the term “arbitrary interval of integers” provides no guidance at all as to what an acceptable range would be. Under the plain and ordinary meaning of “arbitrary,” an “arbitrary interval of integers” could be anything from a single integer to an infinite number of integers.

49. Indeed, the specification explicitly states that the invention cannot be implemented with an arbitrary interval of integers for hue and saturation values. The specification states:

> *In principle*, the numerical range, represented by an interval, [sl, s2], where sl and s2 are integers, of the independent color saturation control delta value, Sclr, in general, and of each Sr, Sg, Sb, Sy, Sc, and Sm, in particular, is arbitrary. *For implementation*, preferably, the numerical range of Sclr, in general, and of each Sr, Sg, Sb, Sy, Sc, and Sm, in particular, is between -1 and + 1, corresponding to the interval [-1,+ 1], which is equivalent to any other interval, [sl, s2], by performing linear or non-linear transformation between these particular intervals.

’435 Patent at 8:4-13 (emphasis added). The specification includes a similar description for hue. *Id.* at 7:46-55. Thus, the specification draws a distinction between a theoretical implementation using an arbitrary range and an actual implementation using a discrete range, with no guidance as to how an “arbitrary” interval of integers could be implemented. Accordingly, the term “arbitrary interval of integers” is indefinite.

H. “completely independent and separate”

50. The term “completely independent and separate” appears in claims 8, 9, 24 and 25 of the ’435 Patent. Each claim is a dependent claim specifying that the “independent color hue control delta value” and “independent color saturation control delta value” are “completely independent and separate.” However, the specification provides no guidance as to what it means for these values – which are already specified as “independent” – to be “completely independent and separate.” Accordingly, it is unclear to a person of ordinary skill in the art what additional

limitations these claims impose. Thus, the term "completely independent and separate" is indefinite.

VI. CONCLUSION

51. I reserve the right to offer opinions in rebuttal to any opinions offered by Plaintiff's expert or experts.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed at Aberdeen, Scotland on September 2nd, 2016

Iain E. Richardson

Iain E. Richardson, Ph.D.

CURRICULUM VITAE

Iain E Richardson

Internationally known expert on video compression standards including MPEG-2, H.264 and HEVC. Author of four widely cited books on video and image coding, experienced expert witness in US and international patent litigation cases.

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Personal Profile

An international expert on compression coding, I am the author of four books and over 70 journal and conference papers on video compression, including two widely cited books on the H.264 / MPEG-4 standards. I regularly advise companies on video compression and streaming technology, video coding patents and technology acquisitions. I have acted as an expert witness in multiple US and EU patent litigation cases. I have given expert testimony in San Diego, New York, Washington DC and The Hague and regularly give invited lectures on video compression coding, most recently at the Smithsonian Institution and the US Patent and Trademark Office.

I have made an internationally significant contribution to research in the field of image and video compression. This is the essential technology for applications such as digital television, internet video streaming and video on mobile phones. My research has addressed the growing challenge faced by industry, namely how to support sophisticated video compression on an increasing range of devices and platforms. I am a member of British Standards Institute expert group IST/37, the committee which represents the UK in ISO/IEC MPEG standardisation.

I invented and commercialised Beamshare, a novel technology for rapid and secure sharing and streaming of video and other media. Beamshare is now in use in industries such as Search and Rescue and broadcast video production.

I am based in the UK and travel several times a year to the US.

Qualifications

M.Eng. (1990), Heriot-Watt University, Edinburgh, UK
Ph.D. (1999), Robert Gordon University, Aberdeen, UK

Employment experience

2006 - present	Managing Director, Vcodex Ltd, Aberdeen, UK
2009 – 2015	Managing Director, Onecodec Ltd, Aberdeen, UK
1993 - 2010	Full Professor, School of Engineering, The Robert Gordon University

1995 - 2000	Director, 4i2i Communications Ltd
1990 - 1993	Digital Signal Processor Designer, GEC Ltd, Edinburgh

Expert witness and intellectual property experience

An experienced expert witness in patent litigation cases, I have testified at deposition and trial in:

1. United States District Court (Southern District of California) Case No. 05cv1958 B(BLM), San Diego, USA, 2006-2007 (Video compression, H.264)
2. United States International Trade Commission Investigation 337-TA-724, Washington DC, 2011 (Graphics compression)
3. United States District Court (Southern District of California) Case No. 3:10-cv-02618, San Diego, USA, 2012 (Video compression, MPEG-2 and H.264)
4. United States International Trade Commission Investigation 337-TA-837, Washington DC, 2013 (Data / video compression, H.264)

I have testified at deposition in:

5. United States District Court (Southern District of California) Case no. 09 CV 0278-H (CAB), USA, 2011 (Video compression, MPEG-2 and H.264)
6. United States International Trade Commission Investigation 337-885, New York City, 2013 (Video compression)
7. Patent Trial and Appeal Board, Inter Partes Review IPR2015-00302, Washington DC, 2015 (Data and video compression)
8. Patent Trial and Appeal Board, Inter Partes Review IPR2015-01089, Washington DC, 2016 (Data and video compression)

I have been engaged by a number of US and EU law firms to provide patent portfolio analysis and expert witness services, including:

- Finnegan, Henderson, Farabow, Garrett & Dunner, LLP
- Cooley LLP
- Young Basile Hanlon & MacFarlane P.C.
- Quinn Emanuel Urquhart & Sullivan, LLP
- Kilpatrick Townsend & Stockton LLP
- Novak Druce Connolly Bove + Quigg LLP
- Polsinelli P.C.

Publications

Books/Chapters/Theses

1. Iain Richardson, *H.264 Advanced Video Compression*, John Wiley and Sons, May 2010.
2. Iain Richardson, *H.264 and MPEG-4 Video Compression*, John Wiley and Sons, 2003.
3. Iain Richardson, *Video Codec Design*, John Wiley & Sons, 2002.
4. Iain Richardson, "Coefficient Modelling in a Block-Based Video CODEC", in IMAGE PROCESSING III: Mathematical Methods, Algorithms and Applications, Horwood Publishing, ISBN 1-898563-72-1, 2001.
5. Iain Richardson, "Video Coding for Reliable Communications", PhD Thesis, The Robert Gordon University, October 1999.

6. Mohammed Ghanbari and Iain Richardson (editors), *Proceedings of International Workshop on Audio-Visual Services over Packet Networks*, 1997.
7. M J Riley and Iain Richardson, *Digital Video Communications*, Artech House, 1997.

Standards contributions

1. Y. Zhao, M. Bystrom, C.S. Kannangara, I. Richardson and J. Philp, "A Random Access Protocol for Configurable Video Coding", Document M16927, ISO/IEC JTC1/SC29/WG11 (MPEG), China, October 2009.
2. I.E. Richardson, C.S. Kannangara, M. Bystrom, J. Philp and Y. Zhao, "Fully Configurable Video Coding, Part 2 - A Proposed Platform for Reconfigurable Video Coding", Document M16752, ISO/IEC JTC1/SC29/WG11 (MPEG), London, July 2009.
3. I.E. Richardson, C.S. Kannangara, M. Bystrom, J. Philp and Y. Zhao, "Fully Configurable Video Coding, Part 1 - Overview", Document M16751, ISO/IEC JTC1/SC29/WG11 (MPEG), London, July 2009.

Journal papers

1. A. Bhat, C. S. Kannangara, Y. Zhao and I. Richardson, "A Full Reference Quality Metric for Compressed Video Based on Mean Squared Error and Video Content", *IEEE Trans. Circuits and Systems for Video Technology*, Vol 22:2, February 2012.
2. A. Bhat, I. Richardson and C. S. Kannangara, "A new perceptual quality metric for compressed video based on mean squared error", Signal Processing: Image Communication, Vol 25, 2010, pp. 588 - 596
3. M Bystrom, I Richardson, S Kannangara and M de Frutos-Lopez, "Dynamic Replacement of Video Coding Elements", *Signal Processing:Image Communication*, Vol 25:4, April 2010.
4. C S Kannangara, I E Richardson , M Bystrom & Y Zhao, "Complexity Control of H.264/AVC based on Mode-conditional Cost Probability Distributions", *IEEE Trans. Multimedia*, April 2009.
5. C S Kannangara, I E Richardson & A J Miller, "Computational Complexity Management of a Real-Time H.264/AVC Encoder", *IEEE Trans. Circuits and Systems for Video Technology*, September 2008.
6. M. Bystrom, I. Richardson and Y. Zhao, "Efficient Mode Selection for H.264 Complexity Reduction in a Bayesian Framework," *Signal Processing: Image Communication*, vil. 23, iss. 2, pp. 71-86, February 2008.
7. C S Kannangara, I E G Richardson, M Bystrom, J Solera, Y Zhao, A MacLennan & R Cooney, "Low Complexity Skip Prediction for H.264 through Lagrangian Cost Estimation", *IEEE Transactions on Circuits and Systems for Video Technology*, February 2006.
8. L Muir and I E G Richardson, "Perception of Sign Language and its Application to Visual Communications for Deaf People", *Journal of Deaf Studies and Deaf Education*, September 2005.
9. I E G Richardson and S Kannangara, "Fast subjective video quality measurement with user feedback", *Electronics Letters* Vol. 40, Number 13, June 2004 pp. 799-800.

10. Y Zhao and I E G Richardson, "Macroblock Classification for Complexity Management of Video Encoders", *Signal Processing: Image Communication*, Vol. 18, Issue 9, Oct. 2003 pp. 801-811.
11. I E G Richardson and Y Zhao, "Adaptive Management of Video Encoder Complexity", *Journal of Real-Time Imaging*, Vol. 8, No. 4, Aug 2002, pp. 291-301.
12. I E G Richardson, M J Riley, W Haston and I Armstrong, "Telemedicine and teleconferencing: the SAVIOUR project", IEE Computing and Control journal, January 1996.
13. I E G Richardson and M J Riley, "Improving the error tolerance of MPEG video by varying slice size", Signal Processing journal, Vol. 46, No. 3, October 1995.

Papers in refereed conference proceedings

1. A. Bhat, I. E. Richardson & C. S. Kannangara, "A Novel Perceptual Quality Metric for Video Compression", Proc. International Picture Coding Symposium 2009, Chicago, May 2009.
2. I. Richardson, C. S. Kannangara, M. Bystrom, J. Philp and M. De. Frutos-Lopez, "A Framework for Fully Configurable Video Coding," Proc. International Picture Coding Symposium 2009, Chicago, May 2009.
3. A. Bhat, I. Richardson and S. Kannangara, "A New Perceptual Quality Metric for Compressed Video", Proc. ICASSP 2009, Taipei, Taiwan, April 2009.
4. C. S. Kannangara, I. Richardson, M. Bystrom, M. de-Frutos-Lopez, "Fast, Dynamic Configuration of Transforms for Video Coding", Proc. ICIP 2008, San Diego, California, October 2008.
5. I E Richardson, "Dynamic Configuration: Beyond Video Coding Standards", Invited Plenary Presentation, *IEEE System on Chip Conference* (SOCC08), Newport Beach, CA, September 2008.
6. I. Richardson, M. Bystrom, M. de-Frutos-Lopez, C. S. Kannangara, "Dynamic Transform Replacement in an H.264 Codec", Proc. ICIP 2008, San Diego, California, October 2008.
7. Chaminda Kannangara, Yafan Zhao, Iain Richardson and Maja Bystrom, "Complexity Control of H.264 Based on a Bayesian Framework", Proc. PCS 2007, Portugal, November 2007.
8. Y Zhao, M Bystrom and I E Richardson, " A MAP Framework for Efficient SKIP/CODE Mode Decision in H.264", Proceedings of International Conference on Image Processing, Atlanta, USA, 8-11 October 2006.
9. C S Kannangara, I E Richardson and A Miller, "Computational Management of an H.264 Encoder," Proceedings of International Picture Coding Symposium, Beijing, China, 24~26 April 2006.
10. I E Richardson, M Bystrom and Y Zhao, "Fast H.264 Skip Mode Selection Using an Estimation Framework", Proceedings of International Picture Coding Symposium, Beijing, China, 24-26 April, 2006.
11. C. S. Kannangara and I. E. Richardson, "Computational Control of an H.264 Encoder Through Lagrangian Cost Function Estimation", International Workshop on Very Low Bitrate Video, Sardinia, Italy, 15-16 September 2005.
12. L J Muir, I E G Richardson and K Hamilton, "Visual perception of Content-Prioritised Sign Language Video Quality". Proceedings IEE Visual Information Engineering, Glasgow. 4 ~ 6 April 2005.

13. Y Zhong, I Richardson, A Miller and Y Zhao, " Perceptual Quality Of H.264/AVC Deblocking Filter", Proceedings IEE Visual Information Engineering, Glasgow, 4~6 April, 2005.
14. C S Kannangara, I E G Richardson, M Bystrom, J Solera, Y Zhao, A MacLennan & R Cooney, "Complexity Reduction of H.264 using Lagrange Optimization Methods," Proceedings IEE Visual Information Engineering, Glasgow, 4~6 April, 2005.
15. I E G Richardson and Y Zhao, "Video Encoder Complexity Reduction by Estimation Skip Mode Distortion", Proc. ICIP 2004, Singapore, Oct. 2004.
16. Y Zhong, I Richardson, A Sahraie and P McGeorge, "Influence of Task and Scene Content on Subjective Video Quality", Lecture Notes in Computer Science, Volume 3211 / 2004, pp. 295.
17. W W Lee, I E G Richardson and R Staff, "Volumetric Analysis of Brain MRI scans Using Geometric Deformable models. ", ESMRMB 2004, September 2004, Copenhagen.
18. C S Kannangara, I E G Richardson and Y Zhao, "H.264 Complexity Management using Macroblock Skip-Mode Prediction", PGNet, Liverpool, June 2004.
19. Y Zhong, I Richardson, A Sahraie and P Mcgeorge, "Qualitative and quantitative assessment in video compression", 12th European Conference on Eye Movements, 20-24 August 2003, Dundee,Scotland.
20. Yafan Zhao and Iain Richardson, "Macroblock skip-mode prEdiction for Complexity control of Video Encoders", IEEE Visual Information Engineering, Surrey, July 2003.
21. Laura Muir, Iain Richardson, Steven Leaper, "Gaze tracking and its application to video coding for sign language", International Picture Coding Symposium 2003, Saint Malo - France, 23~25, April 2003 .
22. Yafan Zhao, Iain Richardson, "Macroblock classification for video encoder complexity management", International Picture Coding Symposium 2003, Saint Malo - France, 23~25, April 2003.
23. Y Zhao and I E G Richardson, "Complexity Management for Video Encoders", Doctoral Symposium, ACM Multimedia Conference, Juan Les Pins, France, 1-6 December 2002.
24. L Muir and I E G Richardson, "Video Telephony for the Deaf: Analysis and Development of an Optimised Video Compression Product", Doctoral Symposium, ACM Multimedia Conference, Juan Les Pins, France, 1-6 December 2002.
25. Y Zhao, L Muir and I E G Richardson, "Implementing MPEG-4 Visual in software", IEE Seminar on Visual Media Standards, 25 April 2002
26. Y Zhao and I E G Richardson, "Computational Complexity Management of Motion Estimation in Video Encoders", IEEE Data Compression Conference (DCC02), Snowbird, Utah, April 2002.
27. I E G Richardson and Y Zhao, "Adaptive Algorithms for Variable Complexity Video Coding", Proc. International Conference on Image Processing (ICIP01), Thessaloniki, Greece, October 2001.
28. I E G Richardson and Y Zhao, "Video CODEC Complexity Management", Proc. International Picture Coding Symposium (PCS01), Seoul, Korea, April 2001 .
29. I E G Richardson, K Kipperman et al, "Video Coding using Digital Signal Processors", DSP World Fall Design Conference, Orlando, USA, November 1999 (invited workshop).
30. M J Riley, I E G Richardson, K Kipperman, L Muir and G Smith, "High speed bit accurate communication system modelling in C", Proc. DSP World Spring Design Conference, Santa Clara, USA, April 1999.

31. I E G Richardson, A J Turnbull and M J Riley, "Temporal Filtering of Coded Video", Proc. SPIE Int. Conf. on Digital Compression Technologies and Systems for Video Communications, Berlin, October 1996.
32. M J Riley and I E G Richardson, "Quality of Service Issues for MPEG-2 Video over ATM", Proc. IEE International Broadcasting Convention, Amsterdam, September 1996.
33. M J Riley and I E G Richardson, "An Optimised Implementation of Reed-Solomon FEC on the PC", Proc. 4th UK/Australian International Symposium on DSP for Communication Systems, Perth, September 1996, published as chapter in "Digital Signal Processing for Communication Systems", Kluwer Academic Publishers.
34. M J Riley and I E G Richardson, "An FEC Protocol for Video over ATM", Proc. Fourth Workshop on Performance Modelling and Evaluation of ATM Networks, Ilkley, W.Yorkshire, July 1996.
35. I E G Richardson and M J Riley, "Controlling the rate of MPEG video by dynamic variation of sequence structure", Picture Coding Symposium, Melbourne, March 1996.
36. I E G Richardson, I J Hunter and M J Riley, "Temporal smoothing of coded video data", Picture Coding Symposium, Melbourne, March 1996.
37. I E G Richardson and M J Riley, "Reducing cell loss effects on MPEG video by varying slice size", International Packet Video Workshop, Brisbane, March 1996.
38. I E G Richardson and M J Riley, "Varying slice size to improve error tolerance of MPEG video", Proc. SPIE vol. 2668, Digital Video Compression 96, San Jose, January 1996.
39. I E G Richardson, M J Riley and A J Miller, "Video Coding and Transmission: Standards and Scalability", Proc. ITU Telecom 95, Geneva, October 1995.
40. I E G Richardson and M J Riley, "Video Quality of Service in Broadband Networks", Proc. IEE International Broadcasting Convention 95, Amsterdam, September 1995.
41. M J Riley and I E G Richardson, "Minimising the Effect of Cell Losses on MPEG Video", Proc. 4th Int. Conference on Broadband Islands, Dublin, September 1995.
42. I E G Richardson and M J Riley, "MPEG Coding for Error-Resilient Transmission", Proc. IEE Image Processing and its Applications 95, Edinburgh, July 1995.
43. M J Riley, B U Kohler and I E G Richardson, "A Variable Block Length FEC Protocol for MPEG Packet Video", Proc. 3rd Int. Symposium on Communication Theory and Applications, Ambleside, July 1995.
44. M J Riley, B U Kohler, I E G Richardson and A J Miller, "Statistical Multiplexing MPEG Video Traffic with FEC", Proc. 3rd IFIP Workshop on Performance Modelling and Evaluation of ATM Networks, Bradford, July 1995.
45. I E G Richardson and M J Riley, "UPC Cell Loss Effects on MPEG Video", Proc. IEEE International Conference on Communications 95, Seattle, June 1995.
46. M J Riley and I E G Richardson, "FEC and multi-layer video coding for ATM networks", chapter in Performance Modelling and Evaluation of ATM Networks, Ed. Demetres Kouvatsos, Pub. Chapman & Hall 1995, pp450-457.
47. I E G Richardson and M J Riley, "Intelligent Packetising of MPEG Video Data", Visual Communications and Image Processing 95, Proc. SPIE vol. 2501, Taipei, May 1995.

48. M J Riley and I E G Richardson, "Adapting MPEG Video Traffic to Avoid Network Congestion", Proc. IEE International Conference on Telecommunications 95, Brighton, March 1995.
49. M J Riley and I E G Richardson, "Error Tolerant Video Transmission using FEC and Multi-Level Coding", Proc. IEEE International Workshop on Intelligent Signal Processing and Communication Systems, Seoul, October 1994.
50. R A Butler, I E G Richardson and M J Riley, "A Multi-Level Video CODEC for Network Distribution in the Presence of Errors", Proc. IEE International Broadcasting Convention pp196-201, ISBN 0-85296-620-2, Amsterdam, September 1994.
51. I E G Richardson and M J Riley, "FEC and Multi-Level Video Coding for ATM Networks", Proc. 2nd IFIP Workshop on Performance Modelling and Evaluation of ATM Networks, Bradford, July 1994.
52. I E G Richardson and M J Riley, "ATM Cell Loss Effects on a Progressive JPEG Video Codec", Proc. 3rd International Conference on Broadband Islands, pp155-165, ISBN 0-444-81905-3, Hamburg, June 1994.

Patents / Patent Applications

1. Iain Richardson, Ying Zhong, Kang Shan, Abharana Bhat and Laura Muir, Method of and apparatus for processing image data, WO 2007144640 A1
2. Iain Richardson and Yafan Zhao, Video encoding with skipping motion estimation for selected macroblocks, WO 200405612
3. Iain Richardson, Selective perceptual masking via downsampling in the spatial and temporal domains using intrinsic images for use in data compression, US 20140269943 A1
4. Iain Richardson and Sampath Kannangara, Encoder control apparatus and method, WO 2007066101 A2
5. Iain Richardson and Sampath Kannangara, Video quality measurement, EP 1585348 A1
6. Iain Richardson and Maja Bystrom, Systems and methods for encoding and decoding, US8995534
7. Iain Richardson and Maja Bystrom, Systems and methods for encoding, transmitting and decoding, US 20120069911 A1
8. Iain Richardson and Maja Bystrom, Systems and methods for encoding, sharing, and decoding of multimedia, US 20130188739 A1
9. Iain Richardson and Maja Bystrom, Systems and methods for encoding and decoding, US 9154797
10. Casey Smith, Iain Richardson and Abharana Bhat, Selective perceptual masking via scale separation in the spatial and temporal domains using intrinsic images for use in data compression, US 8897378